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TITLE: Variable bandwidth variable center-frequency multibeam satellite-switched router

Abstract Text (1):
Reconfigurable switching router connects to an existing connectivity network on board a multibeam communications satellite for increasing the flexibility thereof by providing variable bandwidth capability so that the satellite handles a multitude of individual users having different requirements of bandwidth and transmission rates. The bandwidth of at least one transponder channel is split into two portions. A first portion provides a VBVCF continuous passband while a second portion is further channelized in a reconfigurable fashion to achieve VBVCF subchannelization. The reconfigurable switching router utilizes a class of multi-level channelization formats implemented by a plurality of filter banks connected in parallel. A switching network performs VBVCF subchannel selection and routing via time and/or frequency multiplexing thereby to accommodate both VBVCF SSTDMA and SSFDMA traffic.

Brief Summary Text (3):
In present commercial communications satellite systems operating at 6 and 4 GHz (C-band), 14 and 11 GHz (Ku-band) and 20-30 GHz (Ka Band), on-board connectivity between uplink and downlink beams is carried out on a transponder channel basis by providing "static" switching networks with occasional switch reconfigurations of about fifty to one hundred times per year. Switching schemes employed therein are suitable for carrying Frequency Division Multiple Access (FDMA) continuous traffic. Other satellite systems provide "dynamic" switching with reconfiguration periods of a few milliseconds suitable for carrying Satellite Switched Time Division Multiple Access (SSTDMA) burst traffic. Switching of communications paths between multiple uplink and downlink beams is usually performed by a switch matrix on a transponder channel basis. These on-board switch matrices map input (uplink) traffic into output (downlink) traffic, wherein switch configurations change only the output port connected to a given input port without changing the bandwidths of the respective interconnecting paths. This connectivity will be hereafter referred to as Constant Bandwidth ("CB") connectivity and the associated traffic "CB" traffic.

Brief Summary Text (4):
Present-day CB-FDMA communications systems only employ one-to-one

static connectivity networks between uplink and downlink co-frequency transponder channels and utilize mechanical coaxial switches requiring no D.C. power to hold them in position after actuation. A typical switching for this application is a "rearrangeable switch matrix" architecture using "beta" elements as building blocks. On the other hand, present-day CB-SSTDMA (constant bandwidth satellite-switched time-division multiple access) communications satellite systems employ connectivity networks between uplink and downlink channels which utilize coupler cross-bar Microwave Switch Matrices (MSM) of either diodes or field-effect transistors (FETs) having rise-fall times of a few nanoseconds. No on-board satellite-switched TDMA systems having variable bandwidths are presently known to exist.

Brief Summary Text (5):
When on-board interbeam connectivity is represented by a matrix with entries corresponding to the bandwidths of the interbeam connection paths, then a CB connectivity function for one group of co-frequency transponder channels in a satellite system (e.g. 8 beams) at a given time instant is represented by an 8.times.8 matrix having only one non-zero element in each row or column. The following matrix is typical. ##EQU1## where B.sub.T is a transponder bandwidth for the respective channels. In SSTDMA systems, channel configuration is represented by the same matrix [1], but the non-zero matrix elements change their location periodically in time. A complete representation of the entire satellite interbeam connections comprises a number of such switch matrices equal to at least the number of transponder channels.

Brief Summary Text (7):
Recently, however, in response to traffic demands including a relatively large number of small users, more "intelligent" satellites have been developed which adaptively achieve high satellite design efficiencies via narrow interbeam connectivity paths with reconfigurable bandwidths, e.g., Variable-Bandwidth, Variable Center-Frequency (VBVCF) on-board connectivity. Here, satellite design efficiency is defined as the ratio of saturation capacity to the nominal capacity of the satellite, and provides an indication of how efficiently satellite resources are utilized, such as, how on-board connectivity and antenna coverage match traffic demands.

Brief Summary Text (8):
According to an aspect of the present invention, VBVCF connectivity may be implemented without increasing the number of on-board TWTAs (travelling wave tube amplifiers) by subdividing a transponder bandwidth into a number of narrower channels of varying bandwidth and accommodating within the same transponder different thin route services with different connectivity requirements. Recent on-board TWTA linearization techniques and modulation formats make this design philosophy particularly attractive. As an example, services requiring a continuous band of variable width may be assigned upon demand to a sub-band B.sub.x of transponder bandwidth B.sub.T while the remaining bandwidth B.sub.T -B.sub.x may be channelized into a multiplicity of narrow VBVCF channels suitable for multicarrier traffic with a varying number of different carriers. In its operation, each channel is subsequently routed to a defined

downlink beam by a switching network.

Brief Summary Text (10):
As discussed herein, prior on-board routers for VBVCF connectivity were proposed as early as 1980, mainly in connection with continuous FDMA traffic. For example, U.S. Pat. No. 4,228,401 entitled "Communication Satellite Transponder Interconnection Utilizing Variable Bandpass Filter" and issued on Oct. 14, 1980 describes a system employing a payload which lacks on-board switching capabilities, but features reconfigurable beam interconnections using VBVCF filters achieved by a serial filter architecture. The VBVCF filter utilized therein performs two successive frequency translations of the signal frequency spectrum with respect to the fixed passbands of two equal filters being serially connected. Unfortunately, this technique, although useful for other applications (see, for example, J. Melngilis and R. C. Williamson, "Filter With Bandwidth Continuously Variable From 5 to 100 MHz", Proc. 1977 Ultrasonics Symp. pp. 965-968), has marginal practical utility for linear phase (constant delay time) communication channels due to the adding up of transmission amplitude and phase ripples in the serially connected passband filters in the vicinity of their upper edge frequency. On the contrary, in the inventive router described herein, the VBVCF demultiplexing function is implemented by a switchable combination of passband filters connected in parallel and does not suffer from the adding up of spectral impurities injected by serial filters.

Brief Summary Text (11):
The on-board FDMA routers proposed in the early eighties mainly relate to 30 and 20 GHz multiple beam satellite systems. At these frequencies, a large frequency spectrum is available for commercial satellite communications (2500 MHz times frequency reuse) and, consequently, prior routers were designed on the basis of broadband channelization schemes which accommodate large numbers of elementary channels which are frequency-multiplexed over large bandwidths. Reconfigurability was achieved by sorting out from a large number of available channels those which closely match user demands. For narrowband reconfigurable connectivity, very large filter banks and switch matrices are present in those routers. Hardware complexity as well as weight and volume render these routers unattractive and caused a shift of interest toward alternate on-board routing solutions such as SSTDMA (Satellite Switched Time Division Multiple Access).

Brief Summary Text (15):
It is a more specific object of the present invention to provide a system for reconfigurably dividing a transponder bandwidth into at least two sub-bands of variable width wherein at least one sub-band is further channelized to achieve multiple VBVCF subchannels.

Brief Summary Text (19):
Aspects of the invention are realized by a method and apparatus wherein CB connectivity enhancement is preferably carried out by a device, such as an on-board router, in conjunction with an existing CB connectivity network on board a multibeam communications satellite employing multiple transponder channels. Both CB and VBVCF traffic are beamed to the satellite in uplink beams of given

bandwidths and center frequencies. Upon receipt, the bandwidth of each uplink beam is divided into a number of transponder channels of bandwidth B.sub.T. The transponder channels carrying VBVCF traffic are further partitioned in a number of sub-transponder channels by the on-board router. Of these channels, one provides a continuous band of variable width which is particularly suitable to SSTDMA traffic with variable burst rate.

Brief Summary Text (20):
The method and apparatus can be appreciated with reference to matrix [1] above and assuming VBVCF traffic exists in uplink beams 5, 6, 7 and 8 and downlink beams 4, 5, 7 and 8. The enhanced CB connectivity matrix [2] is as follows: ##EQU2## where "*" entries represent CB traffic and the other entries represent VBVCF traffic. Connectivity paths with bandwidths B.sub.T * are established by a CB connectivity network while paths B.sub.ij (i=5,6,7,8 and j=4,5,7,8) and B.sub.xi (i=5,6,7,8) are established in the on-board router. In matrix [2], bandwidth B.sub.xi is a fraction of a transponder bandwidth B.sub.T, while B.sub.ij are fractions of the remaining B.sub.T -B.sub.xi.

Brief Summary Text (22):
A preferred method to enhance CB traffic in an existing on-board CB network is carried out by interfacing a device, such as an on-board router, with the CB network. The preferred method further includes the steps of dividing the transponder bandwidth into two parts wherein one part is further channelized establishing respective bandwidths and center frequencies of the elementary VBVCF traffic channels, re-routing the VBVCF traffic through the CB network to downlink beams, and controlling the center frequencies and bandwidths (e.g. values of Bxi and B.sub.ij) of the VBVCF channels.

Brief Summary Text (23):
According to the apparatus of the invention, an on-board router is serially connected to and operates simultaneously with CB networks existing on-board the spacecraft. The router includes means to receive VBVCF traffic of given bandwidths and center frequencies, means to partition a transponder bandwidth into at least two sub-bands, means to channelize further at least one of the sub-bands to establish a plurality of elementary channels that carry the VBVCF traffic, and switching means to translate or map uplink to downlink paths within the router and CB network. The bandwidths and center frequencies of the elementary VBVCF channels may be controlled externally.

Brief Summary Text (24):
The system accommodates CB and VBVCF traffic wherein the CB traffic requires constant bandwidth connectivity with occasional reconfigurations and the VBVCF traffic requires variable bandwidth connectivity.

Drawing Description Text (3):
FIG. 1B is a conceptual depiction of bandwidth configuration versus time characteristics of channel routing achieved by the on-board router of FIG. 1A.

Detailed Description Text (2):
Referring to FIGS. 1A and 1B, an on-board router 10 couples with an existing on-board CB connectivity network 12 to achieve CB connectivity enhancement. The router 10 and CB network 12 are located on board a communications satellite and provide reconfigurable interconnection paths between uplink and downlink beams in accordance with exemplary frequency plans 11 and 13, respectively. These paths may carry digital traffic from digitized telephone voice signals and/or data communications systems requiring varying rates of data transmission, as well as varying volumes of analog FM traffic. Further, these paths may accommodate either FDMA or TDMA traffic in accordance with the present invention. As previously indicated, CB refers to Constant Bandwidth transponder traffic whereas VBVCF refers to Variable Bandwidth Variable Center Frequency sub-transponder traffic. The widths of the rectangles within the blocks of frequency plans 11 and 13 generally indicate the bandwidth requirement of the traffic along a specific path. Continuous and dashed lines correspond to CB and VBVCF traffic, respectively. For example, the first four blocks of uplink frequency plan 11 indicate CB traffic, occupying the entire transponder bandwidth B.sub.T whereas the rectangles in the latter four blocks of plan 11 respectively indicate bandwidth requirements of VBVCF traffic in each of the four channels 5-8.

Detailed Description Text (3):
Uplink frequency plan 11 shows a possible transponder channelization according to the previously defined enhanced connectivity matrix [2]. By transponder frequency plan, it is meant a given division of transponder frequency band into a set of sub-bands corresponding to various traffic paths. In each block of plan 11, the two digits in each pair represent respectively the numerical identity of the origin and destination beams as also indicated at the respective inputs and outputs of router 10 and CB network 12 in FIG. 1A. Likewise, downlink frequency plan 13 depicts the character of the downlink channels and also indicates the translated path sequences by origin and destination beam number. More than one pair of digits within the same rectangle indicates that a particular bandwidth is utilized for a multiplicity of interconnection paths. Digit pairs within parentheses refer to SSTDMA traffic, whereas digit pairs without parentheses refer to FDMA traffic.

Detailed Description Text (6):
FIG. 1(B) is a bandwidth-versus-time representation of a hypothetical channelization plan relative to traffic originating from uplink beam no. 5. Digit pairs in FIG. 1(B) representing origin/destination paths correspond to digit pairs shown in FIG. 1(A). Subchannel division also corresponds. At time t=0, the bandwidth B.sub.x5 is initially utilized by an SSFDMA broadcast mode through paths [55], [57], [58]wherein traffic originates in beam 5 and is simultaneously broadcast to downlink beams 5, 7 and 8. At time t=t*, the operation mode changes into an SSTDMA mode with a frame duration of T.sub.1. Within each frame T.sub.1, information in subchannel B.sub.x5 is time-multiplexed through respective paths [55], [57]and [58]. At time t=t.sub.1, a router reconfiguration occurs whereby the bandwidth B.sub.x5 allocated to paths [55], [57]and [58]in the SSTDMA mode shrinks to B'.sub.x5,

and concurrently, the frame duration changes from T.sub.1 to T.sub.2, wherein the multiplexed intervals enlarge. The bandwidth (B.sub.x5 -B'.sub.x5) is now utilized to widen the bandwidth of the [54]interconnection path for carrying SSFDMA traffic. Another reconfiguration occurs at t=t.sub.2. In this case, no bandwidth variation occurs, but the [55]and [57]SSTDMA mode paths with a frame period T.sub.3 are changed into a continuous SSFDMA mode path [57]with the same bandwidth.

Detailed Description Text (8):
Router 10 includes switch matrices and control means for independently routing the respective incoming traffic to specific downlink beams through the network 12. It also includes filter banks for channelizing a portion of a transponder channel at controllable bandwidths and center frequencies thereby establishing narrow band paths for the elementary channels of VBVCF traffic. Preferably, these filter banks have bandpass characteristics with high skirt selectivity. Skirt selectivity in dB/MHz is defined here as the ratio of 39 dB to the 1-40 dB transition bandwidth, i.e. the difference between the 40 dB bandwidth and the 1 dB bandwidth divided by two.

Detailed Description Text (9):
FIG. 2 shows the input section of the router 10 and illustrates a typical frequency partitioning of one of the eight transponder channels. A description of one such channel is exemplary of the remaining transponder channels. FIG. 2 shows an ideal transponder uplink frequency plan 20 relative to a group of co-frequency transponders in an N-beam satellite communications system, an exemplary frequency plan 30 implemented by the on-board router 10, and a band-splitting scheme 60 utilized for achieving the goal of the present invention. A typical satellite communications system includes several such groups of transponders for relaying traffic information among beams. In frequency plans 20 and 30 each traffic channel is ideally represented by a trapezoid whose upper and lower sides demarcate the useful (e.g. 1 dB) and the 40 dB bandwidth. The distance between the upper sides of two adjacent trapezoids will be hereafter referred to as the guardband B.sub.G.

Detailed Description Text (10):
A transponder's center frequency is defined as f.sub.TC =(f.sub.T1 +f.sub.T2)/2 where f.sub.T1 and f.sub.T2 which are the lower and upper edge frequencies, define the 1 dB attenuation points, respectively. As an example, single carrier, variable bit rate traffic in uplink plan 20 occupies a useful bandwidth B.sub.x 22 from f.sub.T1 to f.sub.x1 while multicarrier traffic occupies a bandwidth B.sub.T -B.sub.x from f.sub.x2 to f.sub.T2. In this example, multicarrier traffic is assigned to two connectivity paths 23 and 24 each containing traffic destined to the same downlink beam.

Detailed Description Text (11):
The on-board router frequency plan 30 preferably consists of two fixed adjacent passbands 31 and 32 whose useful bandwidths extend from f.sub.R1 to f.sub.R2 in passband 31, and from f.sub.R3 =(f.sub.R2 +B.sub.G) to f.sub.R4 in passband 32. Passbands 31 and 32 need not be adjacent, but preferably are so to efficiently

utilize the total bandwidth of the transponder channel. Shaded areas in passbands 31 and 32 correspond to beam No. 2 traffic 22, 23, and 24, respectively. Passband 31 is allocated to single carrier traffic and is provided by a fixed bandpass filter with very high skirt selectivity to achieve high spectrum utilization. It is assumed that the 1 dB-40 dB transition bandwidth 33 at the upper edge frequency f.sub.R2 equals the guardband B.sub.G associated with the M-th channelization level of passband 32. Under these circumstances, the adjacent channel interference (ACI) between single carrier and multicarrier traffic is suppressed more than 39 dB. The center frequency of passband 32 is f.sub.RC =(f.sub.R3 +f.sub.R4)/2. It is referred to hereafter as the "router center frequency" whose choice is mainly dictated by the technology utilized for implementing the router's filters.

Detailed Description Text (14):
Passband 32 is reused M times by M filterbanks in the router 10. The M filterbanks are connected in parallel to avoid additive distortion typical in serially connected filters. Each filterbank constitutes a "stage" of a multi-stage "parallel" channelizer and implements a channelization "level" of the multi-level channelization plan. In essence, each filter bank channelizes bandwidth 32 into a number of elementary VBVCF channels. In each stage, the elementary channels differ by their center frequency and may have equal or different useful bandwidths, transition bandwidths and guardbands. According to one arrangement, the N.sub.i passband filters at the i-th channelizer stage have the same nominal values of bandwidth B.sub.i, guardband B.sub.G,i and 1-40 dB transition bandwidth .DELTA.F.sub.i in order to minimize hardware complexity. The channelization level with the smallest number N.sub.1 of elementary channels will be hereafter referred to as the lowest level. The channelization level with the highest number N.sub.M of elementary channels will be referred to as the highest level.

Detailed Description Text (17):
(1) The useful (i.e. 1 dB) bandwidth to be channelized is completely filled by an integer number N.sub.M of elementary channels of bandwidth B.sub.M plus an integer number (N.sub.M 1) of guardbands B.sub.GM, namely:

Detailed Description Text (20):
utilizing a parameter 0.ltoreq..alpha..ltoreq.1 to be chosen on the basis of available resources (e.g. frequency spectrum and filter technology) as well as system requirements. Spectral graphs 60 of FIG. 2 represents a portion of a channelization format with n.sub.i =2 for the three cases of .alpha.=0, for 0<.alpha.<1, and .alpha.=1. For .alpha.=1, transition bandwidth is minimal thus providing more useful bandwidth for carrying information.

Detailed Description Text (24):
having assumed B.sub.GM /B.sub.M =0.25 namely SF.sub.M =1.5. In FIG. 2, the channelization levels shown correspond to above levels i=2, 4 and 5. From Table [13], it is apparent that a consequence of the .alpha.=1 condition is a decrease in SF.sub.i and an increase in .eta..sub.i as the elementary channel bandwidth B.sub.i increases (e.g., lower channelization levels). A decrease of

SF.sub.i to values too close to unity (ideal rectangular box filter) might pose severe technological problems in a practical realization of such filters at the lower channelization levels. For this reason, other channelization formats may be considered, e.g. with smaller values of the parameter .alpha.. In general, for 0.ltoreq..alpha..ltoreq.1, ##EQU3##

Detailed Description Text (28):
If a minimum loading factor LF.sub.min is assumed, then B.sub.X varies within the interval B.sub.X,min multicarrier traffic is within passband 32. Traffic within the bandwidth 32 emerges from port 47 of the paralleling circuit 46. Output 47 is connected to the input 48 of the 1:M power divider 51 which feeds the incoming signals to the M filterbanks 52, 53, 54. Filterbank 52 implements the lowest channelization level and generates N.sub.1 outputs 56 of bandwidth B.sub.1. Filterbank 53 implements the next highest channelization level and generates N.sub.2 elementary channels 57 of bandwidth B.sub.2. The last filterbank 54 implements the highest channelization level M and generates N.sub.M elementary channels 58 of bandwidth B.sub.M. Outputs 56, 57 and 58 are applied to the input ports of a switching network in the router 10 described below in connection with FIG. 3. Although three stages are described to implement the M channelization levels, the invention is not limited to three stages.

Detailed Description Text (41):
FIG. 6 is a detailed block diagram of a preferred on-board router according to an aspect of the invention. Input beams from 1 to N.sub.x bandwidth B.sub.T centered at f.sub.TC as shown in FIG. 2. When switch 116 (which also may be externally controlled like other switches in the CB network) couples the input to the downconverter 111, traffic signals are frequency translated by downconverter 111 by means of local oscillator frequencies f.sub.LO +B'.sub.x, previously described, generated in the synthesized sources 114. A bypass switch 115 connects the synthesized source to the downconverter 111, or alternatively, allows operation with B.sub.X =0. The bypass switch 116 allows the incoming traffic to bypass router processing and apply the incoming traffic directly to the CB connectivity network 12 (FIG. 1A).

Detailed Description Text (42):
Output signals from downconverter 111 are applied to a paralleling circuit 112, previously described in connection with paralleling circuit 46 of FIG. 2, via a connection transmission line 118. Paralleling circuit 112 splits traffic into two streams 121 and 122 which are forwarded to a bandpass filter 113 and to a channelizer 123, previously described in connection with channelizer 55 (FIG. 2) which is connected to a switching network 125, also previously described in connection with switch matrices of FIG. 3. The unit 120 contains the channelizer (CHAN), the paralleling circuit (PAR), the bandpass filter (BPF) and the switching network (SN). The switching network 125 contains two major units: a Single Pole Multi Throw (SPMT) array 126 performing the "Variable Bandwidth" function, and a Cross Bar Switch Matrix (CBSM) 127 performing the "Variable Center Frequency" function and routing of traffic to the downlink beams. The N.sub.x outputs 128 from each of the units 120 are multiplexed back into N.sub.x traffic channels in the output multiplexer 130. Traffic channels at the multiplexer's outputs 134, 135 and 136 are upconverted in the upconverters 141 before being sent to the router's output ports 142. Other units 120 and components thereof operate similarly.

Detailed Description Text (43):
While I have shown and described specific embodiments of this invention, further modifications and improvements will occur to those skilled in the art. For example, bandwidths and frequency specifications illustrated were chosen for purposes of illustrations, and not as a limitation. The bandwidths and operating frequencies may take on a variety of forms and specifications without

departing from teachings herein. Alternative frequency plans may be implemented, not just the one shown and described. Control of all switches may be accomplished by a variety of means, including a processor, relay, or by condition responsive means. Filtering may also be accomplished by a variety of means other than filter banks. For example, digital filtering may alternatively be employed with a concomitant substitution of appropriate components to match the technology of such digital filters in accordance with the teachings herein. Upconverting and downconverting may also be accomplished by various means other than by the use of frequency mixing with a synthesized source. Accordingly, my invention encompasses those modifications and alterations as may come to those skilled in the art based upon the teaching set forth herein and is not limited to the particular embodiments shown and/or described herein.

Other Reference Publication (3):
"Filter with Bandwidth Continuously Variable from 5-100 mhz" by Melngailis et al, 1977, Ultransonics Symposium Proceedings, IEEE Catalog #77CH1264-1SU.

CLAIMS:

1. A variable bandwidth variable center frequency multi-beam satellite communications system which includes multiple transponder channels for interconnecting plural incoming and outgoing communications paths, said system comprising:

A. receiving means for receiving at least one incoming transponder channel of constant bandwidth,

B. band-splitting means connected with said receiving means for dividing the bandwidth of said at least one transponder channel into a first portion and a second portion,

C. multistage channelizing means connected with said band-splitting means for receiving said second portion of said at least one transponder channel, said channelizing means for being operative for further dividing said second channel into multiple levels of subchannels of variable bandwidth,

D. switching means for connecting one-out-of-many input signals with overlapping bands to at least one output port of said transponder at successive time intervals, and for simultaneously connecting plural input signals with non-overlapping band to at least one output port of said transponder, and

E. control means connected to said switching means for controlling the switching of SSTDMA input signals and of SSFDMA input signals.

2. A variable bandwidth variable center-frequency satellite communications system as recited in claim 1 further comprising means for varying the relative bandwidths of said first and second portions.

3. A variable bandwidth variable center-frequency satellite communications system as recited in claim 2 wherein said band-splitting means comprises manifolding means for distributing the signal between said first and second portion with minimal power loss, bandpass filter means for passing the first portion and power dividing means for dividing the signal power of said second portion.

4. A variable bandwidth variable center-frequency satellite communications system as recited in claim 3 wherein said manifolding means includes amplifier means for amplifying the power of the signal of said first and second portions.

5. A variable bandwidth variable center-frequency satellite communications system as recited in claim

2 wherein said channelizing means comprises a plurality of selectable filter banks having high skirt selectivity.

6. A variable bandwidth variable center-frequency satellite communications system as recited in claim 5 wherein said filter banks comprise a plurality of groups of constant bandwidth filters to establish multilevel channelization in a parallel configuration thereby reducing additive losses and distortion of a serial configuration.

7. A variable bandwidth variable center-frequency satellite communications system as recited in claim 6 wherein the filter banks of adjacent subchannels have asymmetric transmission amplitude characteristics at the edges thereof.

8. A variable bandwidth variable center-frequency satellite communications systems as recited in claim 1 wherein said receiving means includes frequency translating means for translating the frequency of said at least one transponder channel.

9. A variable bandwidth variable center-frequency satellite communications system as recited in claim 8 wherein the center-frequency of said translating means matches the center-frequency of said at least one transponder channel.

10. A variable bandwidth variable center-frequency satellite communications system as recited in claim 9 wherein said frequency translating means comprises a local oscillator which includes means for generating a plurality of frequencies to effect center-frequency alignment of said at least one transponder channel.

11. A method for providing variable bandwidth variable center-frequency multi-beam communication in a satellite system which includes multiple transponder channels for interconnecting plural incoming and outgoing communications signals, said method comprising the steps of:

A. dividing the bandwidth of at least one of said transponder channels into a first portion having a first center frequency and a second portion having a second center frequency,

B. channelizing said second portion of the transponder channels into a plurality of groups of subchannels of successive levels of selectable bandwidth,

C. connecting, in accordance with traffic demands, one-out-of-many input signals with overlapping bands to at least one output port of said transponder at successive time intervals, and simultaneously connecting plural input signals with non-overlapping bands to at least one output port of said transponder, and

D. controlling said connecting step by effecting SSTDMA and SSFDMA switching of said respective input and output signals of said at least one transponder channel in accordance with traffic demands.

12. A method as recited in claim 11 wherein said dividing step includes the step of frequency-translating said at least one transponder bandwidth for varying the relative bandwidths of said first and second portions.